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THE MIOCENE SHORE-FISHES OF CALIFORNIA

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RECENT studies of the fossil fishes in the Miocene deposits about Los Angeles and at Lompoc in Southern California, have enabled us to distinguish about sixty-five species of bony fishes, besides a dozen or more species of sharks. Most of the latter are from the shales of Kern County, north of the Tahachapi range. With the exception of two extinct types (*Hemipristis* and the so-called *Wodnika*) the genera are all still represented on the coast. The present paper deals with true fishes only and these belonging to a period roughly estimated as two million years ago.

The study of these fishes of California shows certain facts very clearly.

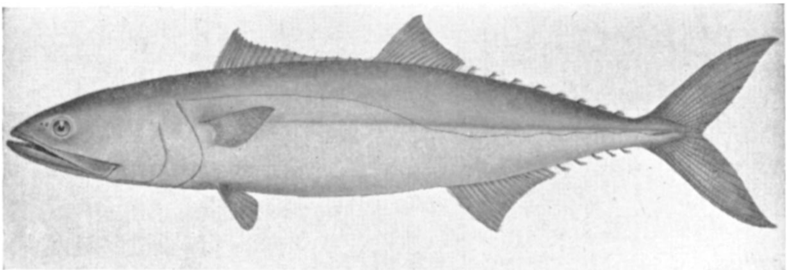
1. The present fauna of California is derived from it, with a certain admixture from the north and from Japan. In the Miocene fauna so far as known there are no types characteristic of Japan.

2. The Miocene fauna is a transitional one, having its roots in the Eocene or Cretaceous. But of neither of these periods have representatives been found in Pacific Coast deposits either in America or Asia.

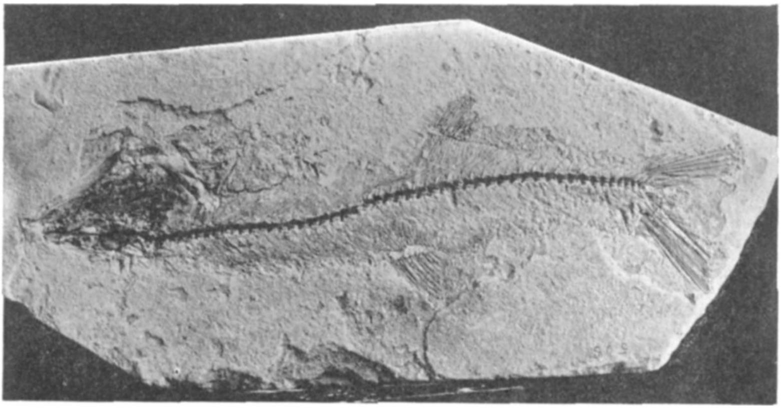
3. The Tertiary fauna of California is nearly all included in families still extant on the coast. All of the species are distinct from their living allies, and most of them must be placed in different genera.

4. The Miocene fauna is plainly ancestral to the present one.

5. The most striking difference which appears is that thus far we have found no trace among the fossils, of the *viviparous* surf-fish (*Embiotocidae*) which form so conspicuous a part in the existing fauna of



THYRSOCLES VELOX (JORDAN AND GILBERT) RESTORED



THYRSOCLES VELOX (JORDAN AND GILBERT) LOMPOC
A Mackerel, Allied to the Spanish Mackerel, Scomberomorus Maculatus (Mitchill).

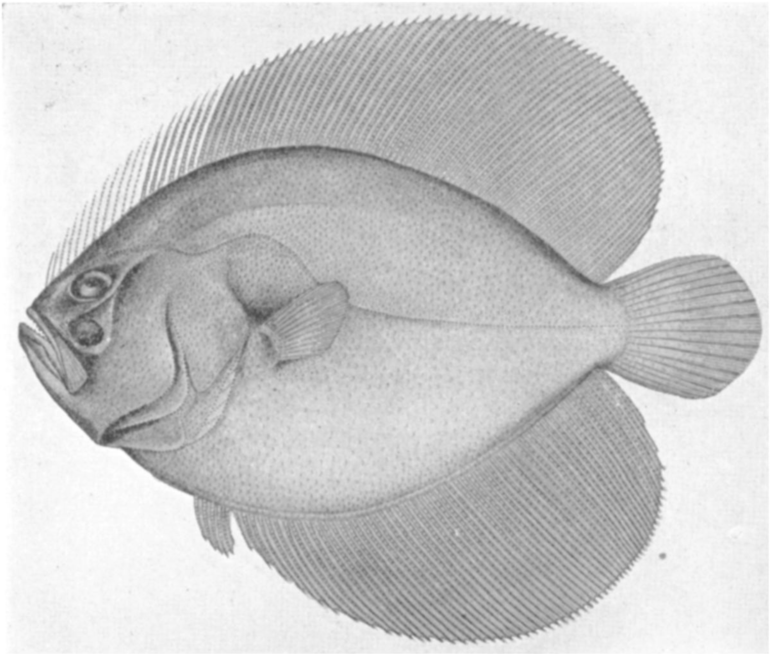
California, and which should abound in just the conditions in which fossils have been preserved. As two genera (*Ditrema Neoditrema*) of this family, representing different sections, are found in Japan, it is possible that the California surf-fishes are of Asiatic origin and have crossed to California in relatively recent times. Among the fossil fishes actually known we find none which suggests any affinity with Asiatic forms. Most of them are distinctly characteristic of California, a few only belonging to types now wanting in California but found in the Gulf of Mexico and in one or two cases in the Mediterranean.

Besides the surf fishes there are some other forms rare or missing which one might have expected to find. Gobies are very scarce although species are now abundant in all shallow waters along the coast. Sculpins (*Cottidae*) now extremely abundant along the coast are wanting. As the Okhotsk region is their center of distribution, they may be late comers in California. There are no sardines, anchovies, or true herring, the extremely numerous herring-like forms being all of extinct genera. We find no blennies, which is also an unexpected fact, as numerous species frequent just such small bays as then occurred in the Archipelago about Los Angeles. There are also no Labroid fishes, forms which now abound in the kelp banks outside the bays.

6. No species either distinctly tropical or distinctly subarctic appear among these Tertiary fishes. We must therefore conclude that the Miocene temperature differed little from that which obtains at present.

7. It is evident from the absence in the deposits containing fishes, of silt or other rain-washed material, that the climate was arid. In the Lompoc deposits of pure diatoms there is no sedimentary material whatever.

8. The localities in which fossil fishes have been found are of two categories:



ZORORHOMBUS VELIGER, JORDAN, (RESTORED)
A flounder allied to the European brill. Bothus rhombus, L.

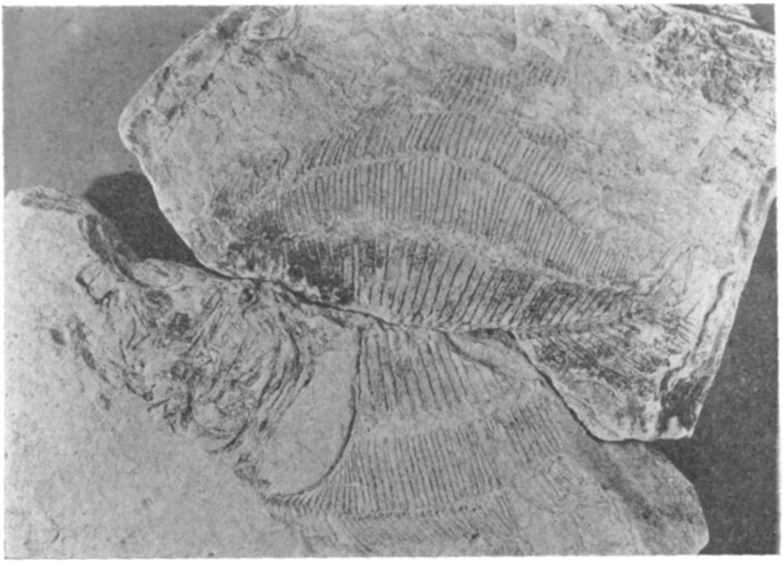
(a) Shallow inlets within a group of small islands scattered about in the region now comprised in the counties of Los Angeles and Orange. The deposits in these little bays are mixed diatoms and fine clay, and the individuals are all either of species of small size or else the young of larger forms. In a few places individuals are found in clay or in fairly hard sandstone, more rarely in pure diatoms. It is a curious fact that the species found about Los Angeles are with the possible exception of two small fishes (*Lygisma, Quaesita*) all different from those taken in the diatom beds at Lompoc.

(b) The deposits of pure diatoms, unmixed with sand or clay, and rarely showing other organisms. Here are found multitudes of fishes, a few birds (petrels, gannets and wading birds) and an occasional porpoise. We found no crustaceans and no echinoderms. There are a few annelids, in one place a small clay bank burrowed full of holes by *Pholadided* or some similar mollusk, and in another place a single shell of some species of *Arca*. With the diatoms are occasional microscopic rhizopods and spicules of sponges.

The Lompoc deposit fills what was once a small narrow-mouthed or bottle-shaped inlet, on the north side of the Sierra Santa Ynez, the backbone of Santa Barbara County. Since these mountains rose from the sea, this little bay of Lompoc became filled with diatoms in incredible numbers to the depth of 1,400 feet. A little stream having eroded one side and large cuttings having been made for commercial purposes, we may now see a section of the whole mass from top to bottom. I have elsewhere[1] shown that a species of herring (*Xyne grex*) had at one time gathered in such numbers as to cover the whole floor of the bay to the exclusion of all other kinds of fish. This was at a level of 950 feet above the sandstone and shales on which the all diatom deposits rest. Among these millions on millions of herring young specimens are not found, all the individuals ranging from 6 inches to 8 inches in length, and not a foot in the whole four square miles so far as yet exposed has less than eight or ten of these fishes. In one single place all by themselves there is a deposit of young herring two or three inches long.

Dr. Edward C. Franklin figures on data which I have furnished that there must have been some 1,200 millions of these herring and that the number of diatoms in the whole bay might be represented by the unit 1 followed by at least 30 ciphers.

Among the herring we find no other kinds of fish whatever, and the question of what caused the sudden death of this vast multitude and the sudden burial in clouds of white diatoms constitutes a problem very difficult to solve. The only clews to the solution have been offered by Dr. Albert Mann, who suggests that the great crowding, whatever its cause, may have raised the temperature of the water, a matter to which



ZORORHOMBUS VELIGER, JORDAN, LOMPOC

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[1] "A Miocene Catastrophe" *Natural History,* American Museum, New York, xx, p. 18, 1920.

herring are peculiarly sensitive. The bulk of the other fishes found are predatory forms which have come to this bay in search of the herring. Two specimens of a large mackerel have herrings in their stomachs. These various forms I have described in two papers written in collaboration with Dr. Gilbert of Los Angeles. These are "Fossil fishes of Southern California" (David Starr Jordan and James Zaccheus Gilbert), Stanford University Publication, University series, 1919 (Sept. 6) and "Fossil fishes of diatom beds of Lompoc" (Jordan and Gilbert), 1. c., 1920 (February).

No fossil fish is ever quite complete—one part or another is wanting. Ordinarily the head is the least satisfactory part. While the bones of the skeleton are picked clean by small organisms in the sea, the soft mass of the brain decays and in rotting it disintegrates the bones which lie around it. Although in most fishes the bones of the head are especially firm and hard, they are very seldom preserved in fossil forms and the student of bony fishes is obliged to give his attention to the skeleton and to the neural and haemal structures which spring from it. The position of the fins can be made out from these bones, but the rays are usually broken. Hence, however determined, there are always elements of doubt as to the accuracy and completeness of any restoration.

No traces of sharks are found in the diatom deposits although multitudes of sharks' teeth are found in the rocks which in other regions overlie the deposits of diatom. As each living diatom contains a minute droplet of oil, it is thought that the great oil deposits of Southern California may come from these masses of diatoms, and it is thus evident that the abundance of sharks' teeth may be an indication of oil. This is especially true in Kern County, where sharks' teeth exist in enormous abundance. It is possible that the oil escapes to the air in regions where, as in Lompoc, the diatom deposits are exposed; but where they are covered by later layers of sand and shale, the oil has been preserved to our own time.